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ABSTRACT

A content analysis was conducted of think-aloud protocols of a teacher who used the Mathematics Assessment Questionnaire (MAQ) to explore the mathematical dispositions of her students. The teacher used the MAQ four times over a 2-year period with geometry students at various levels. On the first occasion, the teacher used a direct instruction model, but she changed to an alternate self-regulatory model based on a student-centered classroom for the other three classes. In addition, a nonroutine geometry problem was used for the last two administrations. After each use of the questionnaire, the teacher talked aloud to researchers while reviewing the student responses. Levels of teacher understanding of student thoughts and feelings about mathematics word problems were coded according to the usually identified levels of understanding and to the types of explanation the teacher used. The case study thus provided the opportunity to explore the teacher's thoughts about her students' responses, particularly in the situation in which her new teaching approach and new type of problem were not well understood by students. The use of types of explanation categories allowed distinctions to be made among the think-aloud episodes that were more refined than those permitted by level or content focus categories alone. (Contains 4 figures and 22 references.) (SLD)

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ED 405 381

Teacher focus, beliefs, and interpretations of students' mathematical dispositions: Content analysis of think-aloud protocols based on a classroom assessment (1)

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Assessments used in classrooms arise from a variety of sources, ranging from those developed by teachers in informal and formal forms, to those assessments accompanying texts or other instructional materials. Any of these assessments might be based on examples or prototypes provided by external developers, as in large-scale state, district, or national programs (e.g., Gipps, Brown, McCallum, & McAlister, 1995; Baker, 1994b). The latter situation may arise when the externally-developed assessments are intended to be well-linked to desired curriculum and instructional goals. Regardless of the sources, assessments selected or developed by teachers are likely to be reflective of teacher goals and instructional practices, in line with teacher professional beliefs or institutional press (e.g., Smith, 1991).

Mathematics offers a particularly fruitful area for assessment rearch and policy studies, since the mathematics education community has provided standards for curriculum and evaluation, professional development, and assessment (National Council of Teachers of Mathematics (NCTM), 1989, 1991, 1995). These documents reflect a fairly unified and consistent framework for the guidance of teachers and others concerned with the teaching and learning of mathematics, and contrast with other areas such as history (Baker 1994a). Parts of the NCTM standards are concerned with mathematical dispositions--attitudes toward learning mathematics, attitudes viewed as important to developing meaningful understanding of mathematics and mathematical problem solving. My example of a content analysis today is drawn from an assessment of attitudes and beliefs about mathematics developed for use in mathematics classrooms (Tittle, 1994).

My purposes in this presentation are threefold:

1. to briefly describe a paper & pencil assessment questionnaire and the initial categories used to characterize teacher understandings;

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2. to briefly describe one teacher's perspectives on this assessment by examining a set of think-aloud protocols;

3. to suggest issues for assessment research and policy recommendations arising from this case example of a teacher and an atypical assessment.(2)

1. The assessment questionnaire and initial categories of teacher levels of understanding

The Mathematics Assessment Questionnaire (MAQ) was developed to provide information to teachers based on student thoughts and feelings about solving mathematical word problems (Tittle, 1994; Tittle & Hecht, 1990). Statements ask learners to reflect on learning and doing mathematical word problems, to assess student characteristics in the context of classroom activities. The student characteristics are (1) awareness of self-regulatory skills and beliefs, and (2) affective, motivational, and attributional beliefs. The three classroom activities are during class (whole group), working with others in a problem solving group, and doing homework, an independent activity. The context of three classroom activity settings was developed to provide more direct links (suggestions) for interpretations both for students and teachers. The domain specifications are given in Figure 1 (from Tittle, 1994, p. 155).

A computer-administered version of the questionnaire was also developed, and is accompanied by a computer-based teacher program (Tittle & Hecht, 1994). A small group of teachers was involved over several years in using the questionnaire in their classrooms one or more times, then participating in a think-aloud procedure (Ericsson & Simon 1984). In this procedure the teacher talks aloud while viewing student and class responses. Of necessity, this also involves the teacher in exploring the structure of the computer program and types of assessment information available.

The teacher program supports examination of individual or class level responses to each item, student written responses to the teacher in a notebook, and a Help feature. Help includes descriptions of available reports as well as suggested instructional activities for all sections of the questionnaire. Metacognitive and self-regulation statements can be examined only item by item. The affective, motivations and attributions also have "possible need" indicators. These are criterion-referenced indicators. The indicators are directly interpreted, based on the criterion that a student selected two of three or three of three responses in a direction suggesting a possible need for follow-up (for example, lack of confidence or anxiety).

Sample screens from this program are shown in Figures 2, 3, and 4. Figures 2 and 3 present screens from Matthew and Jennifer, two above average students in mathematics. The screens have notes each student wrote to the teacher, and indicate the point in the MAQ (question and response) where the note was written. Figure 4 includes screens suggesting needs (for teacher attention), and the statements, responses, and keying of MAQ statements. These screens illustrate student responses and response patterns. Similar screens would be viewed by a teacher looking at individual and class responses during a think-aloud session.

An early description of teacher understandings was based on reviewing the transcripts of the think-aloud sessions. We used ideas of teacher change and development (Fuller, 1969) and the work of Hall and Loucks (1977) which examined teacher adoption and adaptation of innovations. This resulted in proposing a framework of four levels of teacher understanding. These four levels included:

Level 1-- acquiring procedures/conceptual information--the computer program and the types of assessment information, such as class or individual student information, questionable data, CRT indicators.

> e.g., "I like the summary of their responses. Where can I get that?"

Level 2-- contextualizing student responses in the psychological domain, defined as accessing other, relevant information about the student, and interpreting student or class responses conditional on this other information;

> e.g., "Julie...I wouldn't suspect that she didn't like working with other students, but now that I think of it, she is one who likes to stay at her own desk in another part of the room."

Level 3-- using the contextualized information to select or develop specific instructional strategies;

> e.g., "Confidence...she probably doesn't like it when I put her in a group which is why she's withdrawn and that would either make me want to pair her up with somebody that could help her with her anxiety about this or make sure that I give her individual attention."

Level 4-- Internalizing and transforming the assessment information about the psychological domain into other instructional settings and practices.

The examples given here were identified in the transcripts of a small set of teachers. Based on the work in mathematics education research by Schifter and Simon (1992), Schifter and Fosnot (1993), and Franke, Fennema, Carpenter, and Ansell (1992), there should be a shift in the emphasis on the framework at level 4 and the addition of a Level 5. This change reflects the emphasis on studying teacher levels of understanding and teacher levels of beliefs--in a more specified, practice-focused context:

Level 4-- Holds beliefs about students' active construction of beliefs (mathematical dispositions and monitoring) and modifiability of these beliefs in the context of learning mathematics; practice focused on teacher; and

Level 5-- Holds beliefs; uses student beliefs (affective, etc.) in classroom: practice focused on students

- o Focuses on providing opportunities for students to solve problems and talk about their monitoring and affective (and other) beliefs and feelings and

- o Listens to students talking with this framework and uses what is heard to make instructional decisions.

In the case study described below, there are examples of the first three levels of understanding.

2. A case study of teacher protocols: Focus, type of explanation, and levels of understanding.

A recent report by Bean, Fulmer, Zigmond, and Grumet (1995, April) provided an example of extending the analyses of teacher interview transcripts. Episodes (complete statements about an event, explanation, etc.) were coded on dimensions of 1. types of reflections and 2. foci of explanations. In their study teachers reviewed videotapes of their own lessons, and reflected on particular actions and decisions. Reflective statements were coded into five categories: description; explanation with no rationale; explanation based on experience or personal belief; explanation based on theory or principle; and critical (teacher rationale for an event or action was based on a social, ethical or moral dimension). Four focus categories were used: instruction, content, students, and management.

The use of types of reflections provides one approach to integrating the work on teacher beliefs and reflection into analysis of protocols on assessments. In the present instance, I followed a coding procedure that included the dimension of type of explanation used. Explanation, combined with levels of understanding, may provide one approach to describing the depth or quality of teacher understanding of assessment in practice.

The case. During the development and try-out of the computer-based version of the questionnaire, a secondary school teacher used the MAQ four times over a two-year period. She had been teaching (mainly) geometry for five years, and was completing work in a master's program. The types of classes with which she used the MAQ varied ("on level" and one remedial). For the first administration she used a direct instruction model for the self-regulatory statements During Class. She changed to the alternate self-regulation version based on a student-centered classroom model for the other three uses. Further, she experimented with using a nonroutine geometry problem for the metacognitive statements with the last two of the four classes.

Procedures and data analyses. After each use of the questionnaire, the teacher came to the university and the student responses (on disks) were entered into the teacher disk. Then, the teacher talked aloud while reviewing the assessment information (see sample screens in Figures 2, 3, and 4). The think-aloud procedure typically lasted 45-60 minutes. The two researchers answered questions about the program and assessment information, and used queries such as, "What are you thinking now," when the teacher stopped talking. The sessions were audio-taped and transcribed. (3)

In the exploratory analysis reported here, I coded the transcripts using the following system. Each of the four think-aloud transcripts (in order of occurrence, transcripts 1,2,3,4) was marked for episodes. Three dimensions were used for coding each episode: Level of Understanding; Type of Explanation; and Focus (substantive content).

Levels of teacher understanding were described earlier (above). Only the first three levels were coded: level 1, procedures and concepts; level 2, places student responses in context; and level 3, uses for instructional planning.

Types of explanation used are adapted from Bean, Fulmer, Zigmond, and Grumet (1995, April); a description and examples of quotations to illustrate each category are in the appendix. Briefly, episodes were coded for Question/description (Q/D), Explanation with no rationale given (ENR), Explanation based on experience or personal belief (EE), Explanation based on theory or principle (ETP), and Critical (CR).

Focus of episodes are broadly grouped in categories related to the conputer program and assessment information, related to the student thoughts and feelings expressed (Figure 1) on the MAQ, or related to instructional strategies and definitions, etc., given in the Help section of the teacher computer program. The specific coding categories were:

Level 1: Procedures/concepts
a.computer related (management/program)
b.types of assessment information (class/individual,CRT, questionable data)

Level 2: Places in context
a.metacognition/self-regulation
b.affect, motivations, attributions
c.instructional strategies, CRT, Help

Level 3: Instructional plans
a.metacognition/self-regulation
b.affect, motivations, attributions
c.other assessments

Each page of the transcript was coded; the codes were summarized across transcripts. The number of episodes varied for the four transcripts--43, 38, 62, and 44. Results are reported in percents and numbers of episodes.

Results

Table 1 presents the percent of episodes for the four transcripts of the think-aloud sessions. With the exception of transcript three, the number of episodes is similar and shows some trend for a decrease in level 1, procedures and concepts, and a slight increase in level 2, placing the assessment information in the context of the teacher's other knowledge of students. Overall, there were few episodes at level 3 (9%), and a majority (62%) at level 2. The coding of episodes by transcript (time) and type of explanation (not presented here) showed little change, with one exception: transcript 3 had about half of the episodes coded as Q/D. This exception is associated with a particular classroom experience, discussed below.

Table 2 shows the percent of episodes at each level of understanding for each type of explanation. Teacher questions/descriptions and explanations with no rationale are predominant at levels 1 and 2. Level 2 also has explanations based on experience and theory/principle. The episodes coded at level 3 included four of the five types of explanations. Overall, half (50%) of the explanations were coded question/description, with lower percents in the remaining categories. One episode was coded as critical reasoning, at level 2.

In Table 3 the types of explanations are shown for each level/focus of the coded episodes. The 29% of episodes coded at level 1 were about equally divided between the computer and management of the administration, and the type of assessment information provided. These were mainly questions/descriptions. In level 2 the focus was on the

affective, motivational and attributional statements and student responses (30%), and on the self-regulation statements (mainly During Class). The largest frequency of explanations based on theory or principle occurred for the self-regulation statements, the section of the MAQ that the teacher changed to the student-centered During Class. As Table 3 shows, the largest frequency in level 3 (although small overall, at 8%) was on instructional planning in relation to the affective motivational, and attributional statements.

Overall, the distributions of episodes showed few trends by time of transcript, with the exceptions discussed below. The major interest is in the pattern of type of explanation used for the three levels of understanding and the focus of the teacher's episodes.

Discussion

This discussion is based on an exploratory analysis. The participating teacher reviewed the computer-based questionnaire and student responses, with few directions. She had a brief introduction to the questionnaire and computer programs, and had available manuals on the MAQ. However, this teacher, like others, faced many responsibilities and a busy schedule. The use of the alternative self-regulation items During Class reflected her current professional interests, as did the change to the nonroutine geometry problem for the metacognitive statements.

The psychological affective, motivational and attributional statements were very unfamiliar, however. Thus, the "case" and the analysis are also very exploratory from the research perspective as well. Nevertheless, the think-aloud transcripts provide an opportunity to consider analytically how one teacher thinks about her own students' responses to this particular questionnaire with its atypical content focus.

The general categories of levels of understanding are useful in providing a broad picture of the transcripts over time. Even in this limited example Table 1 shows some trends and identifies the anomaly of Level 1, transcript 3. This is the administration when the teacher changed the non-routine problem used for the metacognition statements. She tried out the geometry problem (we obtained from a district mathematics coordinator) with several colleagues and friends. However, her students' responses were not what she expected. The result was an increase in episodes dealing with administration, procedures and management. It was also a very emotional experience for the teacher:

"...the cross problem I checked out with four other

> teachers...so I really didn't think it was going to be any kind of problem...that it was going to be a time problem...and five minutes went by and I got a little panicky (she tried several strategies with students)... (I just said)...you don't understand...I can't believe you don't understand....and then I was so embarrassed and frustrated....(Transcript 3, p.1, 2)

This episode identified another factor for coding when teachers are taking risks and changing their usual practice: teacher affect/teacher focus on self.(4) The miscalculation appears also to have resulted in the teacher reflecting on some of the affective/motivational statements in the MAQ in view of her own personal experiences.

> "...yeah because I think even for myself I had the hardest time with geometry but I love all the other math so it just...there's something about geometry that I think does stick because it's a one time thing... (Transcript 3, p.16)

In transcripts three and four there were a small number of episodes like these (9 and 3 respectively) that were double coded--for the focus categories described earlier and also identified separately here as teacher affect/teacher focus on self. These affective or emotional responses are examples, perhaps, of their role as indices of areas of practice "ripe for change," as described by Goldsmith and Davenport (1995, April). That is, they may indicate areas in which the teacher wants to shift practice, and may be accompanied by emotional reactions.

In summary, the use of the types of explanation categories permit distinctions to be made among the teachers think-aloud episodes that are more refined that either the level or the content focus categories by themselves. Identifying the explanations about student performance that teachers base on experience or personal beliefs, and distinguishing them from explanations based on theory or principle may contribute to understanding teachers' ideas about content, practice, and reform efforts in assessment and curriculum assessment.

The use of the focus categories provide information about where teachers "enter" student assessments. Such information may be diagnostic not only about teacher immediate interests, but also diagnostic about which parts of student assessment responses are most accessible to teachers. Such information may be particularly valuable in supporting teacher development with respect to particular assessments or forms of assessment.

Research and policy implications

There are a number of research and policy implications suggested by this case analysis. The implications are both substantive and methodological.

1. Substantive implications.

One implication for assessment policy and research is that an emphasis should be placed on how assessment links to the main reform efforts. As this case study and other research indicates, it is possible to examine teacher understandings or interpretations of assessments. It is also possible to describe teacher explanations and beliefs about students and classroom practices that can be elicited in reflecting on assessments.

Assessment-related understandings can be matched or contrasted to those expected from the underlying model(s) of classroom teaching and learning represented in curricula and teacher professional development efforts. Often the goals of assessment programs describe positive consequences for instructional practice. Policy research and development needs to include the documentation of teacher interpretations and use in relation to curriculum and instructional practice, as well as understanding how student performance is interpreted.

Assessment policy also should consider the relation of each aspect of an assessment program to the goals for curriculum and instructional practice: communications and/or workshops for teachers about the assessment, the reports for assessments, and any follow-up professional development related to assessment. In the present case (although not described here), it was possible for the teacher to find definitions and instructional suggestions that are linked to all parts of the assessment (the Help feature).

As classrooms are technologically developed, such supports may be possible with large scale assessments as well. This also has policy implications, in terms of provisions for reviews of assessment program materials to examine their links with theory, professional development and curriculum. Research can also focus on examining in more depth teacher understanding, use, and any effects of such materials. Used in conjunction with teacher collaboratives, augmented with videos of exemplars, assessment could be part of an integrated student and teacher development and learning effort.

Current research on teacher development suggests that this is a long-term effort and results will vary for different teachers. Policy recommendations for assessment need a

long-term perspective, and a principled, consistent stance toward change. Research on such attempts to link assessments more directly with professional development efforts can also extend to examination of the affective and emotional responses of teachers as indicators of areas in which they are taking risks to change their practice and student development.

2. Methodological implications.

Several methodological issues can be identified in relation to sampling and the use of procedures for obtaining the interviews and teacher discourse required for analyses. The work of Gipps and her colleagues provides one example of both purposeful sampling and the use of observations and structured interviews. Work on documenting the Quasar project provides another (Forman et al, 1995, April), as does the Bean, Zigmond and Fulmer work (1995, April) that was adapted for the present study. At minimum, the procedures required are observations, preferably videotaped or at least audiotaped, so transcripts can be developed for analysis. These need to be set in context by notes or logs. Teachers can reflect on specific examples identified (by the teacher or researcher). This interview or think-aloud procedure must be audiotaped, transcribed, and provides part of the data for analysis.

Given the desirability of these procedures, sampling of teachers is an issue. Carefully defined, purposeful sampling may yield the most information, identifying teachers likely to represent particular groups of teachers of broader interest.

The use of additional dimensions or interpretive categories, here teacher focus and reflection, provide opportunities to examine Levels 4 and 5, of teacher explanations and teacher practice changes. Although here the teacher focus dimension indicates psychological subject matter (affective, motivational, and so on), more typically the focus would be mathematical understandings of interest to the teacher. The reflection dimension indicates the explanatory beliefs held by a teacher and is a step toward evaluating or indicating the quality of understanding.

The teacher talk aloud procedures during viewing videotapes of classroom practice or while reviewing student assessment products and reports, provides a way of understanding the overlap between assessment intentions (goals), teacher (or principals and other staff) understandings, and their relationships to instructional practice and student performance.

In summary, both policy and research need to be directed toward a better understanding of the relationship between assessments built on theory or reform principles, classroom practice, and teacher and student change. Assessments embody "theory" (Shepard, 1991; Tittle, 1994). Assessments are intended to reflect current principles and goals for student learning and teacher practice. Evidence to date suggests a common-sense conclusion, that assessments are not effective by themselves (Cohen, 1990; Gipps, et al. 1995). At best, assessments can support but cannot "produce" change in individual teachers. Even intensive efforts to facilitate teacher professional development indicates that not all teachers will engage in the process (e.g., Schifter & Fosnot, 1993). These findings need to be taken into consideration in developing assessment policy and research strategies. The findings also provide support for efforts to further explore the extent to which assessment research and policy can support mathematics teaching and learning.

Reference notes

1 Paper presented at the symposium, Research and policy issues for the development, interpretation and use of assessments in classrooms: Examples from mathematics assessment research with teachers, at the meeting of the American Educational Research Association April 10, 1996, New York City.

2 By atypical assessment I mean that the content of the Mathematics Assessment Questionnaire is not typical of the officially stated school curriculum, texts, external assessments, etc. on which teachers would focus classroom assessment efforts.

3 The researchers were myself, as principal investigator on grants funded by the Ford Foundation and the Aaron Diamond Foundation, and Dr. Deborah Hecht, as project associate director. The audio-tapes for these sessions were transcribed by Dana Fusco, research assistant.

4. The MAQ statements are all described from the student's perspective of an activity and thoughts or feelings about the activity. The statements encourage teachers to focus on students in direct interpretations. For example, statements include, "I know when the teacher encourages me to think of different ways to solve problems," "I get bored when working word problems in math class," and, "Word problems seem more important when I am working hard on them with other students."

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Figure 1

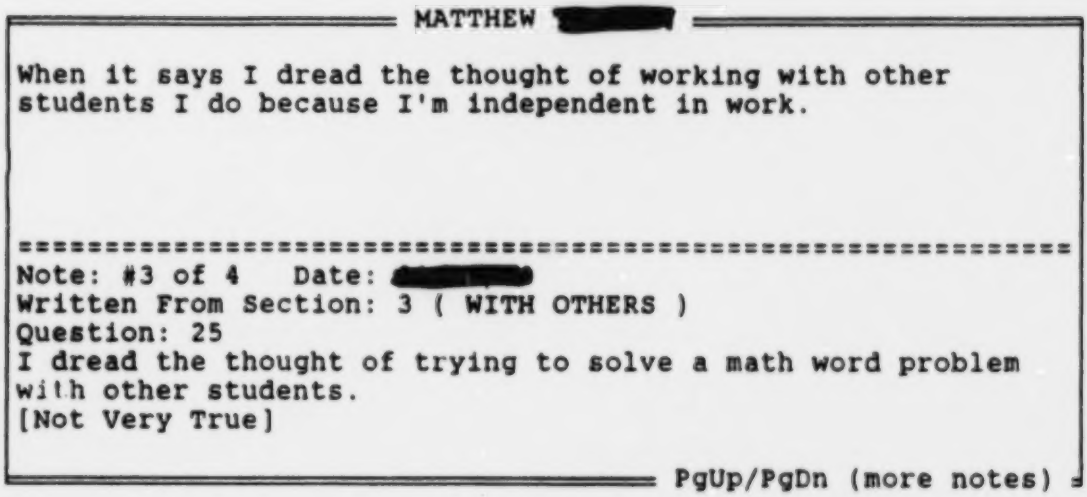
Domain Specifications for the Mathematics Assessment Questionnaire
Illustrating Two Facets: Psychological Construct and Setting

CONSTRUCT	METACOGNITIVE ITEMS NOT LINKED TO SPECIFIC SETTING LINKED TO SPECIFIC PROBLEM
Metacognitive: Solving a math problem	
.Planning, defining objectives----	
.Monitoring progress----------	
.Checking & evaluating----------	
.Strategies employed----------	

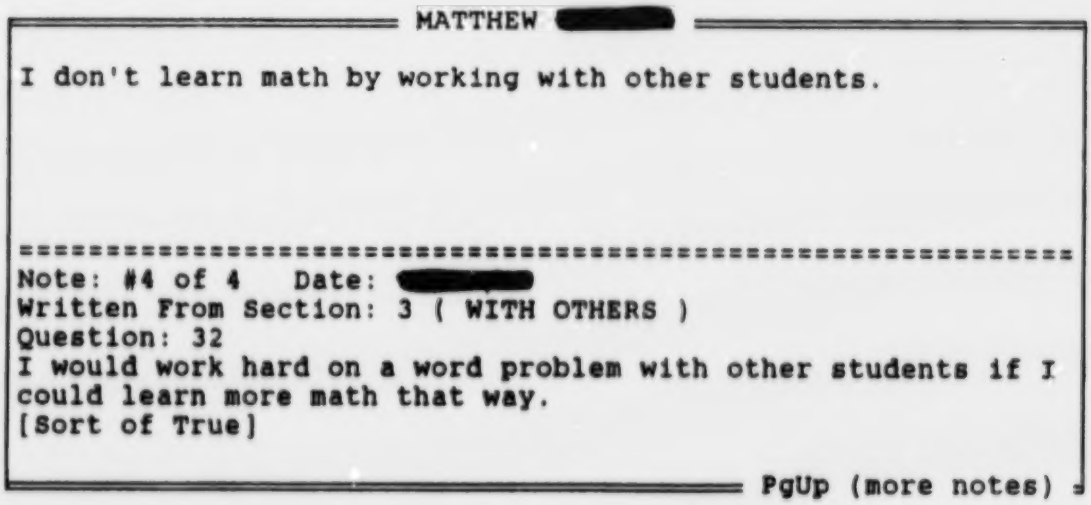
	ACTIVITY SETTING		
CONSTRUCT	During Class	Working with Others	Doing Homework
Self-regulation .awareness of self-directed strategies to learn and work (varies depending upon setting)			
Affective Beliefs			
.Value, utility----------			
.Interest----------			
.Confidence----------			
.Anxiety----------			
Motivations			
.Internal Learning Goals----------			
.External Performance Goals-------			
Attributions			
.Internal Stable Controllable-----			
.Unknown Control----------			

Figure 2

Sample screen prints for Notebook: Matthew


MATTHEW [redacted]
When it says I dread the thought of working with other students I do because I'm independent in work.
Note: #3 of 4 Date: [redacted]
Written From Section: 3 (WITH OTHERS)
Question: 25
I dread the thought of trying to solve a math word problem with other students.
[Not Very True]
PgUp/PgDn (more notes)

F1 Help | P Print | TAB Student


MATTHEW [redacted]
I don't learn math by working with other students.
Note: #4 of 4 Date: [redacted]
Written From Section: 3 (WITH OTHERS)
Question: 32
I would work hard on a word problem with other students if I could learn more math that way.
[Sort of True]
PgUp (more notes)

F1 Help | P Print | TAB Student

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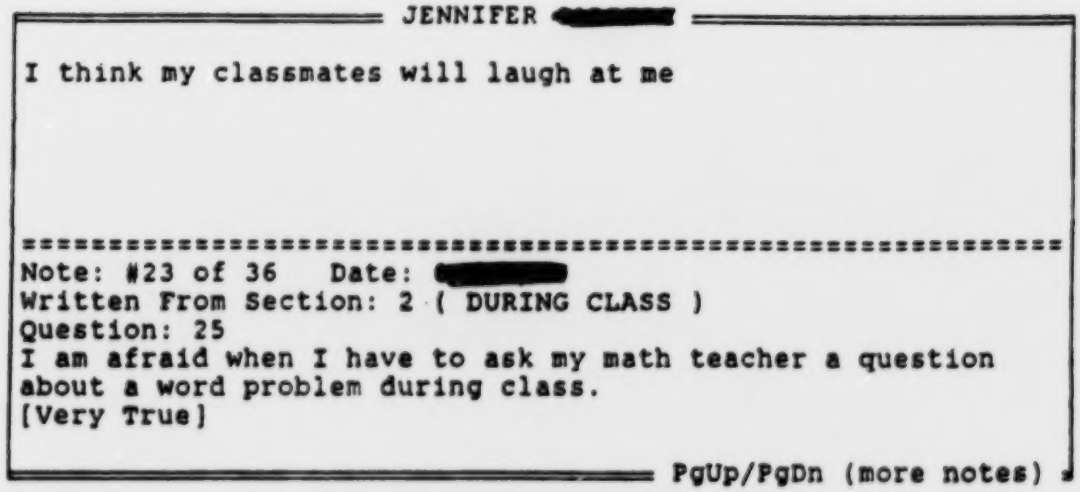
Figure 3

Sample screen prints for Notebook: Jennifer


JENNIFER [redacted]
I think my classmates will laugh at me
Note: #23 of 36 Date: [redacted]
Written From Section: 2 (DURING CLASS)
Question: 25
I am afraid when I have to ask my math teacher a question about a word problem during class.
[Very True]
PgUp/PgDn (more notes)
F1 Help | P Print | TAB Student

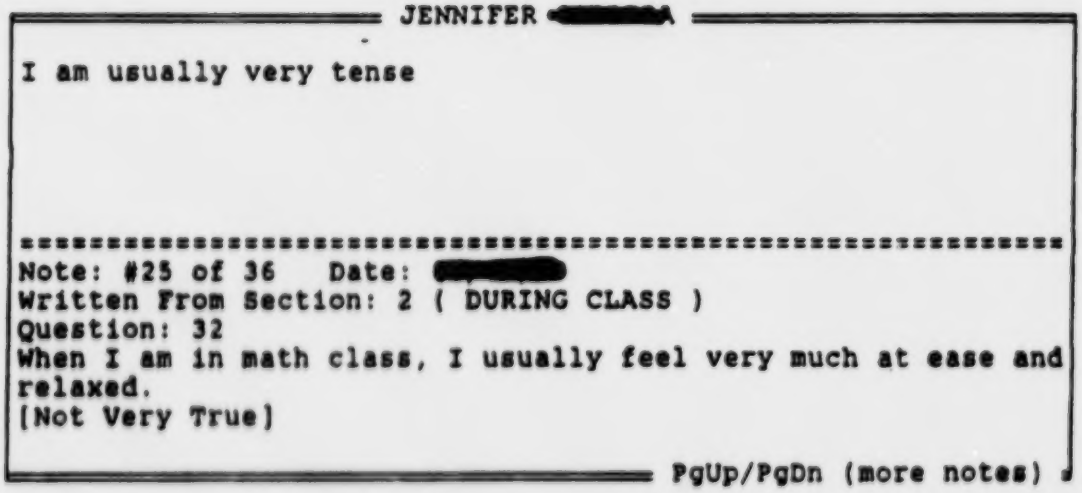

JENNIFER [redacted]
I am usually very tense
Note: #25 of 36 Date: [redacted]
Written From Section: 2 (DURING CLASS)
Question: 32
When I am in math class, I usually feel very much at ease and relaxed.
[Not Very True]
PgUp/PgDn (more notes)
F1 Help | P Print | TAB Student

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Figure 4

Sample screen prints for needs: Jennifer, Damian

JENNIFER [redacted]: Belief Groups suggesting NEEDS

DURING CLASS	WITH OTHERS	FOR HOMEWORK
-ANXIETY		

NEED ANXIETY DURING CLASS

-25. I am afraid when I have to ask my math teacher a question about a word problem during class.[1]
-32. When I am in math class, I usually feel very much at ease and relaxed.[4]
35. I get scared when I have to work a word problem on the board.[4]

0:NA 1:VERY TRUE 2:TRUE 3:SORT OF TRUE 4:NOT VERY TRUE 5:NOT AT ALL TRUE

Groups | +/-/. Strengths/Needs/All

DAMIAN F. [redacted]: Belief Groups suggesting NEEDS

DURING CLASS	WITH OTHERS	FOR HOMEWORK
-CONFIDENCE		-CONFIDENCE
-ANXIETY	-ANXIETY	
-EPG	-EPG	-EPG
-UC		

NEED CONFIDENCE DURING CLASS

20. I feel confident that I will be able to follow any word problem my teacher explains in class.[2]
-28. I do not expect to be able to answer the questions my math teacher asks about word problems.[1]
-42. If my math teacher asks me to solve a word problem on the board, I am sure I will get the wrong answer.[1]

0:NA 1:VERY TRUE 2:TRUE 3:SORT OF TRUE 4:NOT VERY TRUE 5:NOT AT ALL TRUE

Groups | +/-/. Strengths/Needs/All

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